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REMARKS

Applicants add new claims 9-11. No new matter is added. Support for the amendment can be found at least at Page 12, line 24 to Page 13, line 4. Upon entry of this amendment, claims 1-4 and 9-11 are presented for examination. Applicants respectfully submit that claims 1-4 and 9-11 define over the art of record.

Claimed Invention

The claimed invention is directed to a shape memory alloy that has excellent mechanical strength, workability, and shape recovery ratio. The shape memory alloy has a two-phase structure comprising a β-phase having a B2 structure and a γ-phase having an fcc structure, at least 40% by area of crystal grain boundaries of the β-phase being occupied by the γ-phase, where the alloy contains 23 to 27 atomic % of Al and 39 to 45 atomic % of Co, the balance being 28 to 38 atomic % of Ni and inevitable impurities.

To make such a shape memory alloy with at least 40% by area of crystal grain boundaries of the β-phase being occupied by the γ-phase, a one-stage or two-stage heat treatment can be used.

In the case of a one-stage heat treatment, the heat treatment includes a heat treatment step including heating at 1000 to 1350°C for 0.5 to 50 hours and cooling at 10 to 10000°C/minute. See Page 12, lines 24-27. The shape memory alloy resulting from this one-stage heat treatment has at least 40% by area of crystal grain boundaries of the β-phase being occupied by the γ-phase, and hence it provides a satisfactory combination of a tensile strength in the range of 400-1000 MPa and a shape recovery ratio in the range of 18-75%. See Examples 1-6 in Table 1 on Pages 20 and 21 and Figs. 1-2.

In the case of a two-stage heat treatment, the first step is heating the alloy at 1200 to 1350°C for 0.1 to 50 hours and cooling at 0.1 to 1000°C/minute, and the second step is heating at 1000 to 1320°C for 0.1 to 50 hours and cooling at 10 to 10000°C/minute. See Page 4, lines 10-15 and Page 12, line 26 to Page 13, line 4. The shape memory alloy resulting from this two-stage heat treatment has at least 40% by area of crystal grain boundaries of the β-phase being occupied by the γ-phase and hence it provides a satisfactory combination of a tensile strength in

the range of 400-1100 MPa and a shape recovery ratio in the range of 34-90%. See Examples 7-14 in Table 1 on Pages 20 and 21 and Figs. 1-2.

With either the one-stage heat treatment or the two-stage heat treatment described above, a shape memory alloy with at least 40% by area of crystal grain boundaries of the β-phase being occupied by the γ-phase can be obtained, given that the alloy has a two-phase structure comprising a β-phase having a B2 structure and a γ-phase having an fcc structure, and contains 23 to 27 atomic % of Al and 39 to 45 atomic % of Co, the balance being 28 to 38 atomic % of Ni and inevitable impurities.

Claim Rejections

Claims 1-4 under 35 U.S.C. §103(a) as being unpatentable over the English abstract of JP 2002-129273 (hereafter "JP'273") or "Promising ferromagnetic Ni-Co-Al shape memory alloy system" by Oikawa et al. (Applied Physics Letters, vol. 79, no. 20, hereafter "Oikawa"). Applicants respectfully submit that the JP'273 reference or the Oikawa reference does not teach or suggest a shape memory alloy having a two-phase structure comprising a β-phase having a B2 structure and a γ-phase having an fcc structure, at least 40% by area of crystal grain boundaries of the β-phase being occupied by the γ-phase, wherein the alloy contains 23 to 27 atomic % of Al and 39 to 45 atomic % of Co, the balance being 28 to 38 atomic % of Ni and inevitable impurities, as recited in claim 1.

The JP'273 Reference

The Examiner alleges that in the JP'273 reference, alloy sample No. 5 in table 1 meets the compositional limitations in claim 1. Applicants respectfully disagree. Table 1 shows that alloy sample No. 5 has a 39 mass % of Co, 30.5 mass % of Ni, 26 mass % of Al, 4.5 mass % of Mn, and 0.01 mass % of B. In contrast, claim 1 requires the alloy to contain 23 to 27 *atomic %* of Al, 39 to 45 *atomic %* of Co, and 28 to 38 *atomic %* of Ni. Applicants respectfully submit that atomic % is not the same as mass %. Specifically, atomic percentages for sample No. 5 in the JP'273 reference, as calculated from the listed mass percentages, are roughly 30 atomic % of Co, 23 atomic % of Ni, and 43 atomic % of Al. Hence, alloy sample No. 5 in the JP'273 reference does not meet the compositional limitations in claim 1. In addition, the JP'273 reference is silent

regarding the % of area of crystal grain boundaries of the β phase that is occupied by the γ phase.

Accordingly, Applicants respectfully submit that the JP'273 reference does not teach or suggest a shape memory alloy having a two-phase structure comprising a β-phase having a B2 structure and a γ-phase having an fcc structure, at least 40% by area of crystal grain boundaries of the β-phase being occupied by the γ-phase, wherein the alloy contains 23 to 27 atomic % of Al and 39 to 45 atomic % of Co, the balance being 28 to 38 atomic % of Ni and inevitable impurities, as recited claim 1.

The Oikawa Reference

The Oikawa reference teaches an alloy $Co_{40}Ni_{33}Al_{27}$, with about 7 vol % γ, that underwent heat treatment twice, once at 1623K (i.e., 1350°C) for 2 minutes and again at 1573K (i.e., 1300°C) for 15 minutes. See Oikawa, Page 3292, left column. However, this heat treatment applied by the Oikawa reference is different from the heat treatment applied by the claimed invention. Specifically, the claimed invention teaches a two-stage heat treatment where the first step is heating the alloy at 1200 to 1350°C for 0.1 to 50 hours. In other words, the minimum heating time in the first step of a two-stage heat treatment is 6 minutes, whereas the Oikawa reference teaches heating for only 2 minutes in the first step of a two-stage heat treatment. Applicants note that the minimum heating time in the first step in a two-stage heat treatment for the claimed invention is 3 times greater than the heating time in the first step of a two-stage heat treatment in the Oikawa reference. Hence, the Oikawa reference does not teach or suggest the same or even a similar processing of an alloy.

The Oikawa reference also does not teach or suggest a cooling step at a specified cooling rate in its processing of the alloy whereas the claimed invention requires a cooling step at a specified cooling rate after each stage of heating in the two-stage heat treatment. In addition, the Oikawa reference is silent regarding the % of area of crystal grain boundaries of the β phase that is occupied by the γ phase. Hence, the Oikawa reference teaches a very different processing of alloys.

Applicants respectfully submit that the microstructure of an alloy is very sensitive to the details of how the alloy was processed, especially how it was heat treated and cooled. Since the

Oikawa reference teaches a very different processing, the Oikawa reference does not teach or suggest an alloy that exhibits the same microstructures and properties of the claimed alloy.

Accordingly, Applicants respectfully submit that the Oikawa reference does not teach or suggest a shape memory alloy having a two-phase structure comprising a β-phase having a B2 structure and a γ-phase having an fcc structure, at least 40% by area of crystal grain boundaries of the β-phase being occupied by the γ-phase, wherein the alloy contains 23 to 27 atomic % of Al and 39 to 45 atomic % of Co, the balance being 28 to 38 atomic % of Ni and inevitable impurities, as recited claim 1.

Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claim 1. Applicants note that the dependent claims also recite patentable subject matter. As such, for this and the reasons set forth above, Applicants respectfully submit that the dependent claims also define over the art of record.

New Claims

Claims 9-11 are added and depend on claim 1. Claim 9 recites the limitation of a one-stage heat treatment of the shape memory alloy comprising a heat treatment step comprising heating at 1000 to 1350°C for 0.5 to 50 hours and cooling at 10 to 10000°C/minute. Claim 10 recites the limitation that at least 40% by area of crystal grain boundaries comprises a two-stage heat treatment of said shape memory alloy comprising a first heat treatment step comprising heating at 1200 to 1350°C for 0.1 to 50 hours and cooling at 0.1 to 1000°C/minute, and a second heat treatment step comprising heating at 1000 to 1320°C for 0.1 to 50 hours and cooling at 10 to 10000°C/minute. Claim 11 recites the limitation that the first heat treatment step comprises 1350°C for 0.5 hours. Applicants respectfully submit that the new claims recite separate patentable subject matter. As such, for this and the reasons set forth above, the new claims also define over the art of record.

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Application No.: 10/804,244

Docket No.: TAW-008RCE

CONCLUSION

In view of the above amendment, Applicants believe the pending application is in condition for allowance.

Applicants submit herewith a Request for Continued Examination. Applicants believe no other fee is due with this statement. However, if an additional fee is due, please charge our Deposit Account No. 12-0080, under Order No. TAW-008RCE from which the undersigned is authorized to draw.

Dated: February 5, 2007

Respectfully submitted,

By _____

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